Upper Raft River Valley
Water Quality Monitoring Report
Cassia County, Idaho

Developed for:

East Cassia Soil and Water Conservation District
Lake Walcott Watershed Advisory Group

Prepared by:

Mark V. Dallon
Water Quality Analyst
Idaho Association of Soil Conservation Districts
Twin Falls, Idaho

September 2001

Technical Results Summary #2

Upper Raft River Valley Water Quality Monitoring Report
Cassia County, Idaho

By Mark V. Dallon

Idaho Association of Soil Conservation Districts
Technical Results Summary #2
September 2001

Idaho Association of Soil Conservation Districts
Twin Falls Field Office
1441 Fillmore St. Suite A
Twin Falls, ID 83301
(208) 736-7349

Executive Summary

The Raft River is a tributary of the Snake River in south central Idaho. Originating in northwestern Utah, the river drains approximately 1500 square miles in Utah and Idaho before emptying into the Snake River 30 miles east of Burley. All 75 miles of the Raft River in Idaho are included on the state of Idaho 303(d) list of streams that do not meet their designated uses. A Total Maximum Daily Load (TMDL) will be established for all the streams on the list in the Raft River watershed by the end of 2002.

The East Cassia Soil Conservation District promotes best management practices in the Upper Raft River Valley. A project led by the East Cassia SWCD, the Raft River Flood Control District and the Cassia County Commissioners was organized to install stream bank stabilization structures in the Almo subwatershed. Edwards and Almo Creeks, which flow into the Raft River, were the focus of the project. At the beginning of this monitoring project, a separate project was being planned to implement practices along the Raft River. The Raft River project was not implemented, however. Water quality monitoring was requested by the East Cassia SWCD to determine water quality conditions before the projects were implemented.

Data was collected from three sites on the Raft River, two sites on Edwards Creek and one site on Almo Creek from June of 1999 to June of 2000. Samples and measurements were taken for total suspended solids, bacteria and stream discharge. Results indicated distinct water quality differences between the Raft River and the Almo subwatershed.

Total suspended solid concentrations on the Raft River were greater than 50 mg/L as a monthly average at all three monitoring for several months of the project. Even with precipitation and stream flow levels below 70% of normal during the project, sediment levels exceeded the potential TMDL standard over 25% of the time. Higher precipitation and stream flow levels would likely increase sediment concentrations.

Water quality concerns in the Almo subwatershed consisted primarily of bacterial contamination, particularly in Almo Creek in the town of Almo. Concentrations of both fecal coliform and E. Coli were above state standards regularly and were often well above standards. Although total suspended solids are low in the Almo area, bank erosion and gully formation were apparent near the confluence of Edwards and Almo Creeks. Granitic soils in the Almo subwatershed are transported by the streams as bed load, not as suspended loads. Unregulated water diversions and pasture flood irrigation appear to be eroding banks and moving large amounts of sediment that were not quantified by our sampling of total suspended solids.

Agricultural best management practices in the Upper Raft River Valley should focus on two main areas. Livestock grazing along streams should be managed to improve riparian vegetation and to reduce bacterial contamination from livestock by reducing direct access to streams. Irrigation diversions and flood irrigation of pastures should be improved to eliminate unregulated flow of flow during spring runoff.

Table of Contents

List of Figures and Tables iii

Acknowledgements iv

Introduction 1
Upper Raft River Valley 1
The Raft River TMDL 1
Project Objectives 3

Monitoring Methods and Sites 3
Monitoring Site Locations 3
Sampling Schedule and Parameters 4
Sampling Methods 4
Flow Measurements 4
Water Quality 5
Field Measurements 5

Results and Discussion 6
Water Quality 6
Stream Discharge 6
Raft River 6
Edwards and Almo Creeks 8
Total Suspended Solids 9
Raft River 10
Edwards Creek and Almo Creek 12
Bacteria 13

Conclusions 14
Raft River 14
Edwards and Almo Creeks 15

Recommendations 16
Raft River 16
Edwards and Almo Creeks 16

References 17

Appendix A: Quality Assurance/Quality Control 18

Appendix B: Water Quality Data 21

List of Figures and Tables

Figures

Figure 1. The Raft River Watershed 2
Figure 2. Monitoring Site Locations 3
Figure 3. Stream Discharge on Raft River at USGS Gage 1307800 7
Figure 4. Stream Discharge Measurements at Raft River Monitoring Sites 8
Figure 5. Stream Discharge Measurements at Almo and Edwards Creek Monitoring Sites 9
Figure 6. TSS Concentrations at Raft River Monitoring Sites 11
Figure 7. TSS Concentrations at Almo Subwatershed Monitoring Sites 12

Tables

Table 1. Potential Raft River TMDL Limits 2
Table 2. Monitoring Site Descriptions 4
Table 3. Water Quality Parameters and Field Measurements 4
Table 4. Water Quality Parameter Analysis Methods 5
Table 5. Field Measurement Methods 5
Table 6. Precipitation at Malta, Idaho: June 1, 1999 – June 30 2000 6
Table 7. TSS Concentration Monthly Averages 1999-2000 10
Table 8. E. Coli Bacteria Concentration 13
Table 9. E. Coli and Fecal Coliform Values 1999-2000 14
Table 10. Duplicate Mean Values and Comparison 19
Table 11. Relative Percent Difference (duplicates) 20

Acknowledgements

A big thanks goes to Suzette Fraser of the East Cassia Soil Conservation District for her help in planning and organizing this project. Suzette was involved in the 319 grant process and planning the restoration practices. She played a huge role in working with landowners, planning monitoring site locations and providing information on where installation of best management practices was to take place.

Kirk Campbell and Gary Bahr of the Idaho State Department of Agriculture deserve recognition for all their help with technical assistance, suggestions and supervision of the project.

Introduction

The Idaho Association of Soil Conservation Districts (IASCD) collected water quality data from several streams in the Upper Raft River Valley from June 1999 through June 2000. The monitoring project was designed to provide the East Cassia Soil Conservation District (SCD) with water quality data on the Raft River, Edwards Creek and Almo Creek. Implementation of streambank restoration practices on lower Edwards and Almo Creeks began in late 1999. Similar practices were planned for implementation along the Raft River but were not finished. The water quality data was intended to document water quality conditions before implementation of the practices so comparisons to data collected in the future will be possible. A Total Maximum Daily Load (TMDL) will be developed for the Raft River drainage by the end of 2002 and data collected will also give planners important information on current pollutant concentrations and loads. This data will be used to plan implementation of voluntary agricultural best management practices (BMP) throughout the Upper Raft River Valley.

Upper Raft River Valley

The Raft River is a tributary of the Snake River in south central Idaho. The Raft River watershed, hydrologic unit code (HUC) #17040210 drains approximately 1500 square miles in Utah and Idaho. It originates in northwestern Utah and enters Idaho in southern Cassia County approximately 7 miles south of the town of Almo. The river runs a total of approximately 75 miles from the Utah/Idaho border to the Snake River.

The Raft River enters the Upper Raft River Valley near the Utah/Idaho state line. The Upper Raft River Valley is a broad, alluvial valley with mountains on all sides except to the east where the river exits the valley at The Narrows. The drainage area of the Raft River at the Narrows is approximately 400 square miles, or 28% of the total watershed (USGS, 2000). Land use in the Upper Raft River Valley is dominated by grazing and agricultural activities, although recreation and isolated residential impacts exist in the City of Rocks National Reserve and near the town of Almo. Precipitation averages near 15 inches annually in the valley and over 30 inches in the mountains to the north, south and west (WRCC, 2001). The Raft River's flow pattern is dominated by high flows during periods of snowmelt in late winter and spring and extremely low flows during late summer and fall.

The Almo subwatershed is located within the Upper Raft River Valley, draining the east side of the Albion Mountains and the area surrounding the town of Almo. There are several intermittent and perennial tributaries of the Raft River draining from this subwatershed, the largest of which are Edwards Creek and Almo Creek. Edwards Creek is the largest tributary of the Raft River in the Upper Raft River Valley.

The Raft River TMDL

A Total Maximum Daily Load (TMDL) will be written for the Raft River drainage by the state of Idaho's Department of Environmental Quality before the end of 2002. The TMDL will include load limits for each stream and pollutant listed in the state of Idaho 303(d) list. The 303(d) list includes all water bodies in the state that are not meeting their designated beneficial uses. The entire length of the Raft River in the state of Idaho is included on the list, with bacteria, dissolved oxygen, salinity, sediment and temperature listed as parameters of concern. Neither Edwards Creek nor Almo Creek are included on the 303(d) list.

The Raft River TMDL will likely set load and concentration limits similar to those set in other TMDLs in the Southern Idaho area. Many TMDLs have based load limits on the concentration of pollutants in the water. Limits for sediment and bacteria on the Raft River could be similar to other TMDLs in southern Idaho and the values shown in Table 1 are approximately what other TMDLs have set as standards. The actual values for sediment concentrations will not be determined until the Raft River TMDL is prepared by the Idaho Department of Environmental Quality in 2002. The values listed here are estimations and are listed simply to provide a reference to compare with the data collected during this project.

Table 1. Potential Raft River TMDL Limits

Pollutant	Upper Snake Rock TMDL Concentration Limit
Total Suspended Solids	50 mg/L monthly average maximum 80 mg/L daily average maximum
Fecal Coliform	500 colonies/100 mL (cfu) for primary contact recreation 800 cfu for secondary contact recreation
Eschericia Coli	406 cfu for a one time measurement for 126 cfu 30 day geometric mean

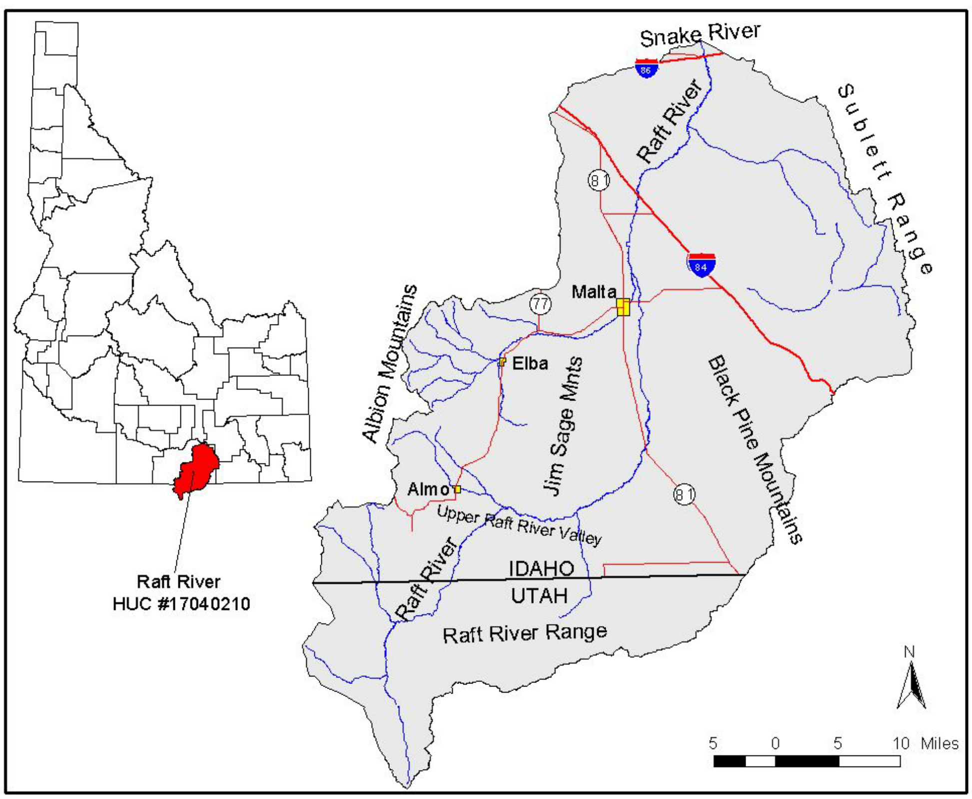


Figure 1. The Raft River Watershed

Project Objectives

Objectives for this monitoring project were established prior to the beginning of monitoring in June of 1999. The objectives were determined after meetings with the East Cassia SCD and were included in the project plan written at that time (Dallon, 1999). The objectives were to:

- Provide baseline data of water quality and flow before implementation of structures.
- Establish photo points to document stream corridor condition before and after implementation of BMPs.
- Assess existing water quality conditions and impacts from agricultural activities.
- Identify upland and agricultural areas of concern for implementation of BMPs to reduce sediment delivery.
- Use the data for public awareness.

Monitoring Methods and Sites

Monitoring Site Locations

The monitoring sites for this project were selected based on their location in relation to planned bioengineering projects, other tributaries, access points and a United States Geological Survey stream gage station. Seven sites were monitored. Site EC2 was dry for all but the first three sampling trips and data from that site is not included in the results. The sites are numbered from downstream to upstream. Descriptions of their locations are included in Table 2 and a map of the sites is shown in Figure 2.

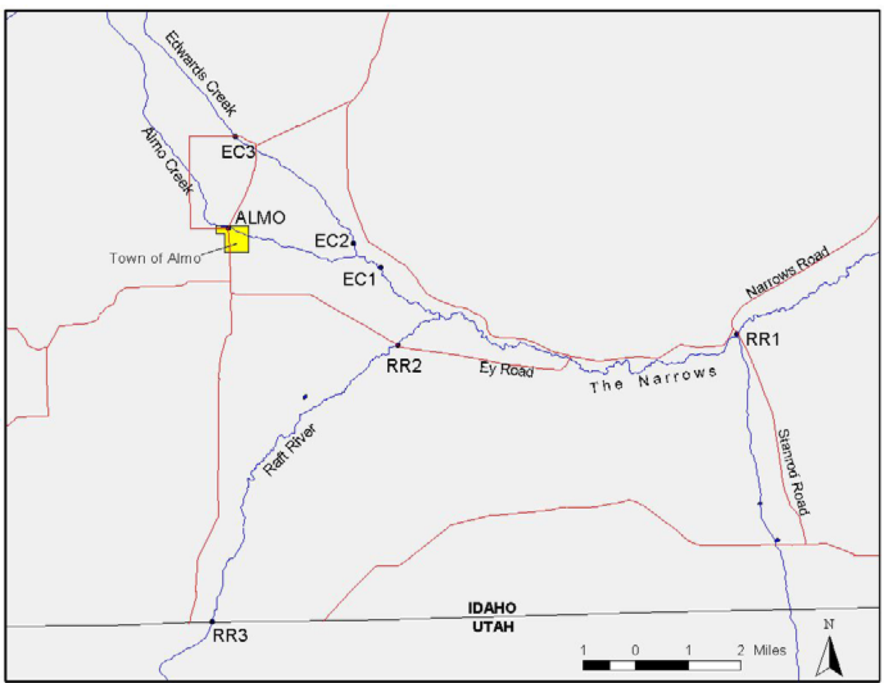


Figure 2. Monitoring Site Locations

Table 2. Monitoring Site Descriptions

Site	Description
RR1	Raft River at Stanrod Road, ¼ mile below USGS gage.
RR2	Raft River at Ey Road, 4 miles southeast of Almo.
RR3	Raft River at Utah/Idaho state line.
EC1	Edwards Creek 1 ½ miles above confluence with Raft River.
EC2	Edwards Creek ¼ mile above confluence with Almo Creek.
EC3	Edwards Creek ½ mile upstream of Elba-Almo Highway.
Almo	Almo Creek in town of Almo.

Sampling Schedule and Parameters

Sampling was done twice a month from April to October and once a month from November to March. This schedule was followed at all sites over the entire project. Twenty sampling trips were made to all sites and samples were collected for pollutants included in the state 303(d) list. The parameters for which samples were taken are included in Table 3.

Table 3. Water Quality Parameters and Field Measurements

Water Quality Parameters Sampled	Field Measurements
Total suspended solids (TSS)	Dissolved oxygen
Total volatile suspended solids (TVSS)	Water temperature
Fecal coliform bacteria	Conductivity
Eschericia Coli bacteria	Total dissolved solids
	pH
	Stream discharge

Sampling Methods

Sample collection techniques followed approved United States Environmental Protection Agency (USEPA) and/or United State Geological Survey (USGS) methods. All analytical testing followed either USEPA or Standard Methods for the Examination of Water and Wastewater (SM) approved methods. Quality Control samples (duplicates and blanks) comprised 10 % of the sample load during this program. Quality Assurance and Quality Control (QA/QC) results are in Appendix A. Chain-of-custody protocols were followed for all sample handling. A detailed description of the procedures used is included below.

Flow Measurements

Flow measurements were collected with a Marsh McBirney Flow Mate Model 2000 flow meter. The six-tenth-depth method (0.6 of the total depth below water surface) was used when the depth of water was less than or equal to three feet. A transect line was set up perpendicular to flow across the width of the stream and the mid-section method for computing cross-sectional area along with the velocity-area method was used for discharge determination. The discharge was computed by summation of the products of the partial areas (partial sections) of the flow cross-sections and the average velocities for each of those sections.

Water Quality

Samples for water quality analysis were collected by grab sampling directly from the stream. For shallow sites (< 1ft) grab samples were collected by hand using a clean one-liter stainless steel container. A DH-81 integrated sampler was used at sites with water depths greater than 1 foot. With all methods, individual samples were collected at equal intervals across the entire width of the stream. Each discrete sample was composited into a 2.5-gallon polyethylene churn sample splitter from which samples were poured off into sample containers. Bacteriological samples were collected directly from the midstream discharge into sterile sample bottles. Analytical methods, preservation and holding times for each parameter are included in Table 4.

Table 4. Water Quality Parameter Analysis Methods

Parameters	Sample Size	Preservation	Holding Time	Method
Non Filterable Residue (TSS)	200 ml	Cool 4°C	7 days	EPA 160.2
Total Volatile Residue (TVSS)	200 ml	Cool 4°C	7 days	EPA 160.4
Fecal Coliform	250 ml	Cool 4°C	30 hours	Standard Methods
Eschericia Coli	250 ml	Cool 4°C	30 hours	Standard Methods

Field Measurements

Field measurements for dissolved oxygen, specific conductance, pH, temperature and total dissolved solids were taken in well-mixed sections, near mid-stream at approximately mid-depth. Calibration of all field equipment was in accordance with the manufacture specifications. All field measurements were recorded in a bound logbook along with pertinent observations about the site, including weather conditions, flow rates and personnel on site. Refer to Table 5 for a list of field measurements, equipment and calibration techniques.

Table 5. Field Measurement Methods

Parameters	Instrument	Calibration
Dissolved Oxygen	YSI Model 55	Ambient air calibration
Temperature	YSI Model 55	Centigrade thermometer
Conductance and TDS	Orion Model 115	Conductance standards
pH	Orion Model 210A	Standard buffer (7,10) bracketing for linearity

Results and Discussion

Water Quality

Water quality in the Raft River drainage is generally a function of stream discharge. High discharges generally result in higher levels of suspended solids. Lower discharges and warmer temperatures during summer allow bacteria to survive longer in a smaller volume of water, creating higher concentrations of bacteria. Additionally, water quality was distinct between the Raft River and the creeks in the Almo subwatershed. Results from the Raft River and the Almo subwatershed will be discussed separately.

The following sections contain results of data collected at the monitoring sites. Data results for stream discharge, total suspended solids and E. Coli bacteria will be discussed individually. Since differences between the Raft River and its tributaries in the Almo subwatershed were distinct in concerns they will be addressed separately. Spreadsheet data for all measured field parameters and laboratory results during the project are included in Appendix B.

Stream Discharge

Raft River

Stream discharge is highly dependent on precipitation. To assess precipitation during this project, data from the nearest weather station at Malta and stream flow data from a United States Geological Survey (USGS) stream gage were compared with average values at those same stations. The USGS gage (gage 13078000) is located on the Raft River just below the Narrows and ¼ mile above site monitoring site RR1. Malta is approximately 17 miles north of the USGS gage. Precipitation data is shown in Table 6 and stream flow levels are shown in Figure 3 for the period corresponding with this monitoring project, June 1, 1999 through June 30, 2000.

Precipitation at Malta totaled 7.28 inches (ISCS, 2001), which is 59% of the average (1963 – 2000) of 12.44 inches (WRCC, 2001). Winter was the only period with precipitation close to normal. Fall and spring were especially dry. Average flow at the USGS stream gage on the Raft River was 13.6 cubic feet per second (cfs), which is 67% of the average annual flow of 20.4 cfs (USGS, 2001).

Table 6. Precipitation at Malta, Idaho: June 1, 1999 – June 30 2000

	Jun-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Total
Average (1963 - 2000)	3.93	2.25	2.21	4.05	12.44
1999 - 2000	2.34	0.82	2.18	1.94	7.28
% Normal	60%	36%	99%	48%	**59%**

Source: National Weather Service Station 105563

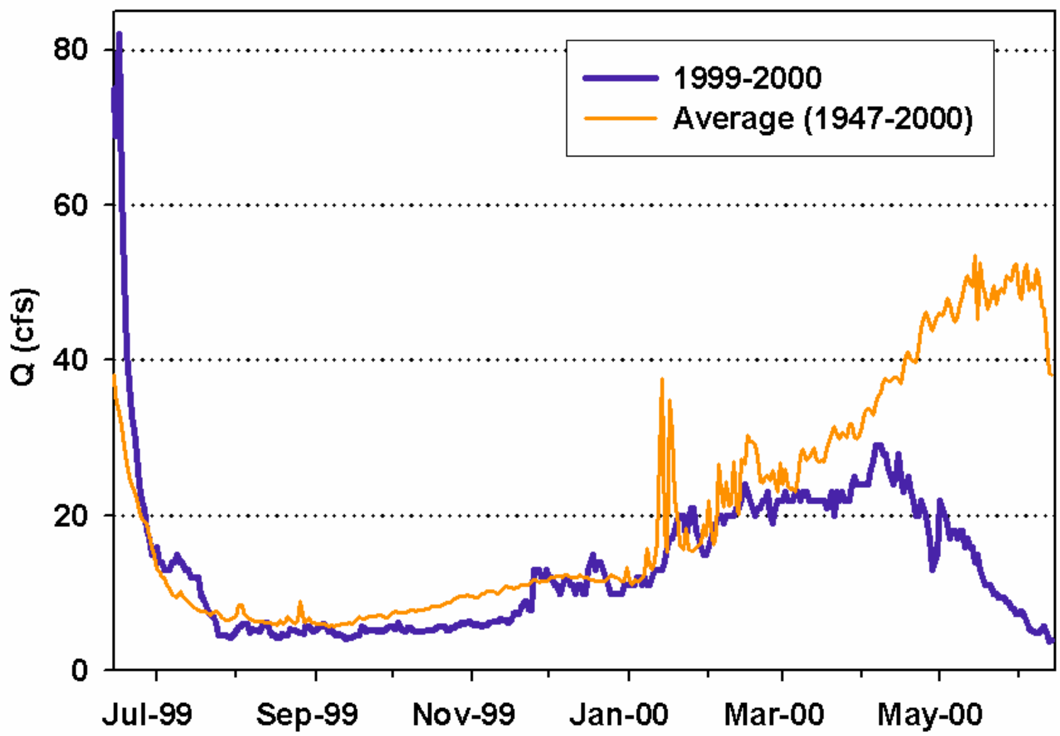


Figure 3. Stream Discharge on Raft River at USGS Gage 1307800

IASCD measurements during the project showed an increase in stream discharge on the Raft River from upstream to downstream (Figure 4). The highest mean flow was 16.5 cfs at RR1. Base flow at RR1 was a consistent 4-6 cfs due to springs and seeps located through The Narrows. Some of the flow may be the result of pumped groundwater from a landowner upstream of the USGS gage site. Flow above the springs is more variable and both RR2 and RR3 were dry for at least part of the project.

Site RR2 had an average flow of 9.0 cfs but had flows below 1.0 cfs for four months in the summer of 1999. Flows at RR3 were extremely low for the same period as RR2 and the channel was dry after mid May 2000 due to irrigation withdrawls in Utah. Winter flows at RR2 and RR3 were generally about 60% of flows at RR1. Local residents indicated that the Raft River is dry from July through October at the Utah/Idaho border during below average precipitation years.

Low stream flows over much of the Raft River appear to be an important factor in the condition of water quality and the overall condition of the Raft River. The river channel through the Upper Raft River Valley experiences extended periods of zero flow during the summer of dry years. The lack of water reduces the amount of riparian vegetation along stream banks and the amount of root structure available to reduce bank erosion during spring runoff.

Stream flow levels play a large role in pollutant loads and the ability of the Raft River to develop riparian vegetation. However, vegetation also plays a role in the ability of the Raft River to store spring flows and increase summer flows from groundwater seepage into the channel.

Improvements in riparian vegetation and the conditions of stream banks should benefit flow conditions in the river by increasing bank storage and reducing spring runoff peak flow levels.

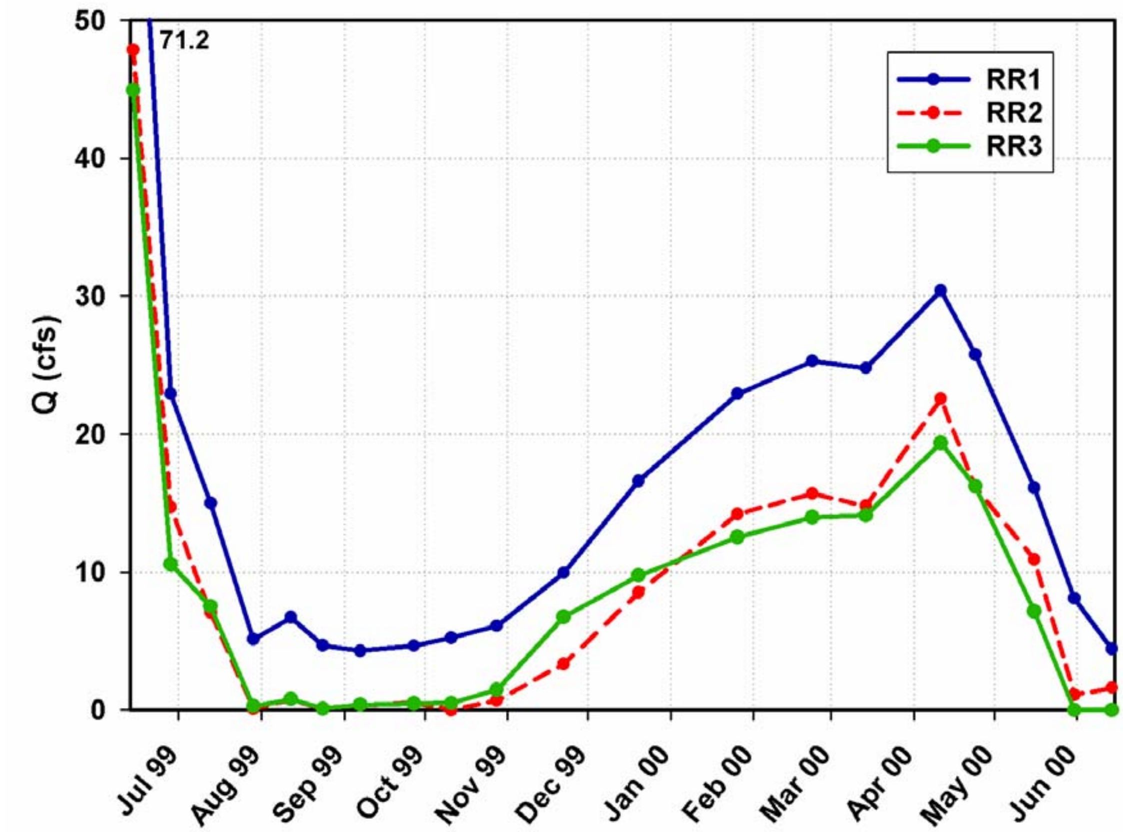


Figure 4. Stream Discharge Measurements at Raft River Monitoring Sites

Edwards and Almo Creeks

Stream discharge on Edwards Creek was generally very low during this project. The only variation was the first measurement taken in June of 1999. The highest average flow at any of the sites was 2.0 cfs at EC1, which includes flow from Edwards and Almo Creeks. However, the median flow at EC1 was 0.34 cfs. Only two values were recorded over the mean value of 2.0 cfs. The maximum flow of 45.5 cfs in June of 1999 was the only measurement over 2.8 cfs and when that value is excluded, the average flow at EC1 was 0.8 cfs for the year of monitoring. Furthermore, the runoff from the 1998-1999 winter was 165% of normal on the Raft River (USGS, 2001). The high flow of 45.5 cfs on Edwards Creek was runoff from a very wet winter. Typical high flows from the Almo subwatershed to the Raft River are probably somewhere between the 45.5 cfs of 1999 and the peak of 1.8 cfs in 2000. However, numerous stream channels and erosional features exist near site EC2 and indicate that flows are frequent and large enough to erode banks and move sediment in the lower sections of Edwards Creek. Stream bank erosion and head cutting near site EC2 were the target of the implementation projects through the 319 project organized by several local groups (East Cassia SCD et. al., 1998).

Base flow along the lower sections of Edwards Creek originates from seeps and springs near the confluence of Edwards and Almo Creeks. During average runoff years, snowmelt from the

Albion Mountains reaches the site during spring runoff. The average flow of 0.7 cfs at EC3 is diverted below the Elba-Almo Highway. After the high flows of June 1999, no flow from upper Edwards Creek reached the lower reaches at EC1.

Stream discharge in Almo Creek is affected by flow diversions for irrigation of pasture upstream of and in the town of Almo. The creek at our site was at or near zero flow from July until mid-October. The peak flow measured was 7.7 cfs. High and low flows at this site are modified or caused by irrigation diversions upstream of the site. The vast majority of the water flowing past this site did not reach Edwards Creek due to irrigation diversions downstream.

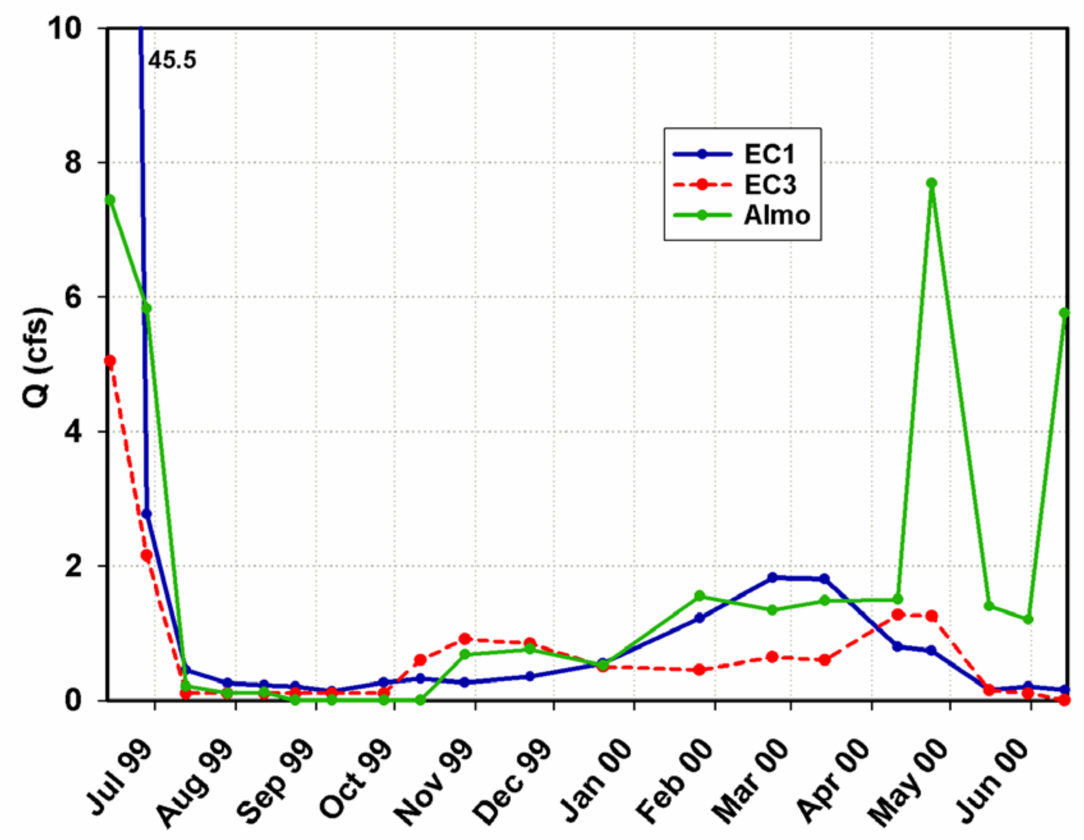


Figure 5. Stream Discharge Measurements at Almo and Edwards Creek Monitoring Sites

Total Suspended Solids

Total suspended solid concentrations for the six sites were generally below 50 mg/L. None of the sites exceeded 50 mg/L on an annual basis and the sites on Edwards and Almo Creeks were well below it. However, the 50 mg/L limit used in other TMDLs is a monthly average and three of the sites (all on the Raft River) exceeded 50 mg/L several times. Monthly TSS concentration averages at all sites are shown in Table 7. Monthly averages over 50 mg/L are shaded and indicate concentrations that would be above the potential standard.

Table 7. TSS Concentration Monthly Averages 1999-2000

values in mg/L

	Sites						
	TMDL	**RR1**	**RR2**	**RR3**	**EC1**	**EC3**	**Almo**
Jan	50 [a]	69	131	61	6	1	1
Feb	50 [a]	74	49	18	8	12	4
Mar	50 [a]	31	54	33	25	29	5
Apr	50 [a]	84	92	59	7	33	30
May	50 [a]	32	30	18	6	8	10
June	50 [a]	51	40	52	14	24	25
July	50 [a]	10	12	6	10	8	10
Aug	50 [a]	6	11	4	4	5	5
Sep	50 [a]	8	10	6	20	2	— [b]
Oct	50 [a]	6	10	4	8	18	5
Nov	50 [a]	4	53	12	3	11	4
Dec	50 [a]	29	48	20	6	3	1

Shaded cells indicate values above 50 mg/L

[a] Approximate future TMDL standard

[b] Stream flow zero; no data collected

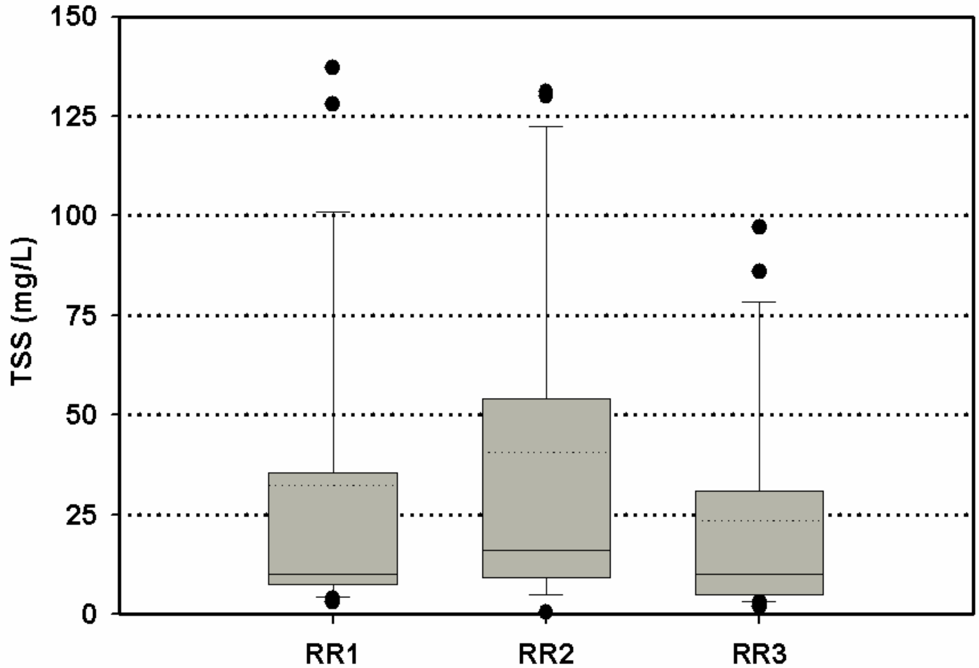
Raft River

The only monthly averages over 50 mg/L occurred at the sites on the Raft River. RR1 and RR2 had four months above 50 mg/L, while RR3 had three. Additionally, all the months above 50 mg/L at the three sites were between November and June. Even with flow levels on the Raft River at less than 70% of normal, TSS concentrations exceeded the potential standard for several months at each site. TSS levels during normal runoff years could be much higher.

The highest TSS concentrations recorded at RR1 and RR3 were the first samples taken in June 1999 at the tail end of spring runoff. These high TSS values corresponded with the highest stream flows measured during the project. Spring runoff during early 2000 was extremely low and stream flow and TSS levels peaked during the period January-April. A box plot of the TSS concentrations at the Raft River sites is shown in Figure 6.

RR1 had the highest annual sediment load of the three sites at 4199 lbs/day, although RR2 exceeded it occasionally during the winter. RR2 had an annual load of 3093 lbs/day. Sediment concentrations were comparable at RR1 and RR2 so the higher average stream discharge at RR1 was the main factor in the load differences. RR3 had the lowest load of the three at 1726 lbs/day.

Figure 6. TSS Concentrations at Raft River Monitoring Sites



Total suspended solid loads appeared to be related primarily to streambank erosion due to lateral movement of the river channel and transport of the eroded material downstream. Runoff and sediment delivery from upland areas to the channel was not observed during this project. However, discussions with landowners after June of 2000 have indicated that runoff from areas burned in 2000 are contributing large amounts of sediment to the channel from upland areas. During normal precipitation years, the impact of upland range conditions on water quality in the Raft River is probably much greater.

The river channel through the Upper Raft River Valley is incised anywhere from 6-12 feet, but does not appear to be degrading currently. The river is eroding laterally within the incised valley and is eroding the vertical banks and widening the valley. The channel will most likely continue to migrate laterally by eroding at the alluvial valley walls until the valley is widened to accommodate the river. However, land management will play a role in how quickly this occurs and whether the channel down cuts any further. Livestock grazing is the primary land use directly along most of the Raft River through the Upper Raft River Valley and intense grazing appears to be limiting the establishment of riparian vegetation along the stream channel in some areas. As discussed in the stream discharge section, any improvement in riparian vegetation will benefit sediment levels and summer flow levels.

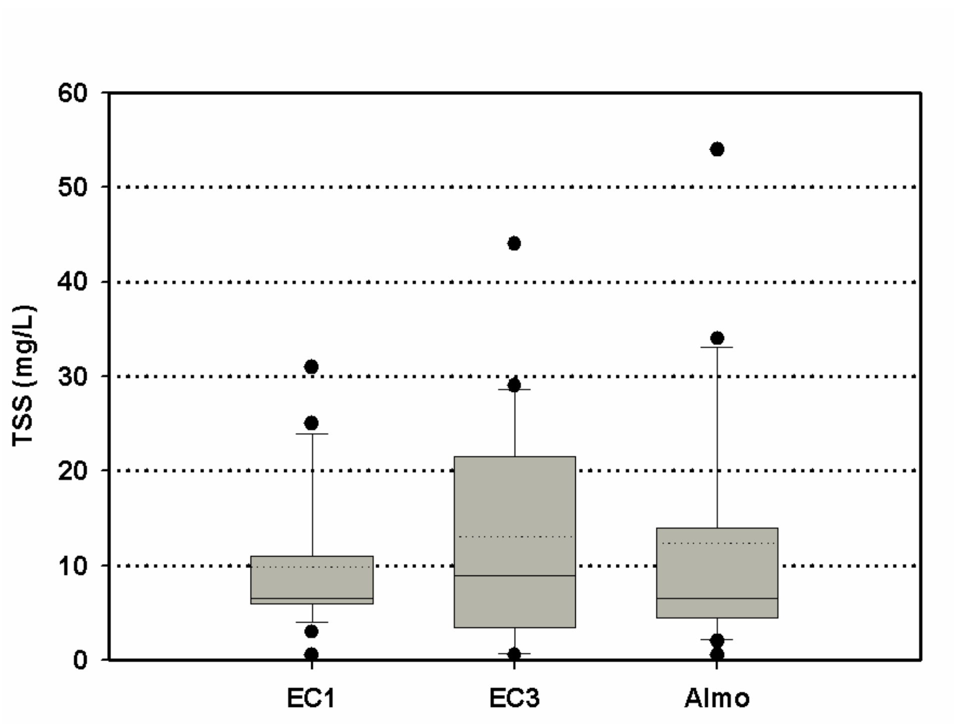
The development of riparian vegetation seems to be a key in reducing sediment loads in the Raft River. Lateral stream movement and bank erosion seem to be the main non-point sources of sediment to the channel. Any improvements in riparian vegetation and stream bank cover as a result of changes in grazing management would reduce sediment input to the channel and increase the development of floodplain deposits that will increase summer stream flows.

Edwards Creek and Almo Creek

The sites on Edwards and Almo Creek are noticeably different from the Raft River. No site had a monthly average above the 50 mg/L value during the project. In fact, TSS monthly values averaged below 15 mg/L at all sites. The geology of the Almo subwatershed is important to consider with respect to these values. The Albion Mountains are predominantly granitic. The course, granitic soils are transported primarily as bed load, not as suspended load. Even during the relatively high flows of June 1999, the TSS concentration was only 31 mg/L at site EC1. Although suspended solid loads were low, movement of coarse sediment along the bed was observed. In addition, flows from the Almo subwatershed are typically very low except during the spring. Average annual loads for total suspended solids at the sites were 147 lbs/day at Almo, 141 lbs/day at EC1 and 67 lbs/day at EC3.

Total suspended solid concentrations and loads were at acceptable levels in the Almo subwatershed. However, overall sediment transport could actually be high. A large percentage of the sediment moves as bed load and was not accounted for by measuring suspended solids. Total suspended solids are not high, but unregulated water diversions, flood irrigation of pasture and livestock grazing are concerns along Almo and Edwards Creek where erosion is occuring. Erosional features and eroding cut banks are prominent along the lower sections of Edwards Creek and at the confluence of Almo Creek. Head cutting of incised channels and erosion of pastureland due to unregulated flow from flood irrigation may account for a large percentage of the sediment delivered to lower Edwards Creek and the Raft River.

Figure 7. TSS Concentrations at Almo Subwatershed Monitoring Sites



Bacteria

Samples were collected for both E. coli and fecal coliform bacteria. The state of Idaho has recently adopted water quality standards for E. Coli levels in surface water bodies. Prior to E. Coli standards, the state standard was for fecal coliform bacteria. For fecal coliform the standard was 500 colony forming units (CFU) for a water body where primary contact recreation was a designated beneficial use and 800 cfu where secondary contact recreation was designated. For E. Coli a one-time measurement of 406 cfu or greater (primary) or 576 cfu (secondary) requires four more samples to be taken within a thirty day period. A geometric mean of the five total samples is not to exceed 126 cfu. Annual mean values for E. Coli at each of the sites are shown in Table 9 and bacteria values for each sampling event throughout this project are shown in Table 10. Sample values equal to or greater than the 800 cfu standard for fecal coliform or 576 cfu for E. coli are shaded.

All of the sites exceeded the fecal coliform standard of 800 cfu at least once. Sites RR1, RR2 and RR3 had 1, 3 and 1 measurements over 800 cfu, respectively. EC1, EC3 and Almo had 9, 4 and 9 measurements over the standard, respectively.

Sufficient data was not collected to determine geometric means for E. Coli. However, 5 of the 6 sites had at least one measurement over the 576 cfu trigger value. As with fecal coliform, the sites on Edwards and Almo Creeks had significantly higher values than the Raft River sites. EC1 and Almo had a high percentage of samples that exceeded state standards with Almo Creek showing particularly high concentrations. Eight of the sixteen measurements exceeded the standard for E. Coli at that site, and some of them were extreme. Almo Creek also has the highest potential for contact with humans as area children were frequently seen playing in and near the creek. Potential sources of bacteria include wildlife, livestock and septic systems. Livestock and septic sources seem to be the most likely at this site since wildlife impacts are not unique to Almo Creek among the six monitoring sites and livestock is concentrated along the creek upstream of the town of Almo.

Table 8. E. Coli Bacteria Concentration

Site	Annual Mean	Median	Minimum	Maximum	n
RR1	100	95	<2	800	20
RR2	337	70	<10	3000	19
RR3	89	75	<10	400	18
EC1	660	155	<2	>10000	20
EC3	226	70	<10	2000	19
Almo	1380	650	<10	>10000	16

Table 9. E. Coli and Fecal Coliform Values 1999-2000

units in colonies per 100 ml (cfu)

	RR1		RR2		RR3		EC1		EC3		Almo	
Date	E. Coli	Fecal	E. Coli	Fecal	E. Coli	Fecal	E. Coli	Fecal	E. Coli	Fecal	E. Coli	Fecal
14-Jun-99	200	300	100	1000	100	300	450	800	400	600	1000	2000
28-Jun-99	20	130	50	160	60	140	100	80	20	90	900	1120
13-Jul-99	100	300	150	400	300	400	300	1100	100	280	10	600
29-Jul-99	800	1700	10	180	300	700	300	1200	200	600	40000	160000
12-Aug-99	70	310	150	1300	210	1600	30	60	40	900	150	510
24-Aug-99	100	400	90	200	400	500	200	1200	300	1400	—[a]	—[a]
7-Sep-99	100	300	50	700	40	110	400	1200	150	500	—[a]	—[a]
27-Sep-99	70	200	200	500	100	200	21000	47000	100	300	—[a]	—[a]
11-Oct-99	180	220	—[a]	—[a]	100	200	2300	3000	2000	2700	—[a]	—[a]
28-Oct-99	70	70	3000	3100	200	230	1000	1400	1200	1400	900	1200
22-Nov-99	40	50	300	400	20	60	10	10	300	600	90	110
20-Dec-99	40	70	<10	70	<10	<10	<10	70	20	130	30	260
26-Jan-00	<2	80	240	280	10	40	<2	40	30	50	80	100
23-Feb-00	20	90	<10	20	<10	10	100	100	<10	20	800	900
14-Mar-00	100	200	20	20	90	110	<10	180	20	200	<10	200
11-Apr-00	100	300	10	200	30	170	<10	120	<10	150	500	800
24-Apr-00	100	100	20	40	<10	20	130	170	70	210	1100	1700
16-May-00	10	30	20	150	10	40	20	100	40	90	100000	150000
31-May-00	90	120	70	100	—[a]	—[a]	180	200	40	150	3300	3300
14-Jun-00	100	130	100	100	—[a]	—[a]	560	1100	—[a]	—[a]	100	100
#violations/n	1/20	1/20	1/19	3/19	0/18	1/18	3/20	9/20	2/19	4/19	8/16	9/16
%	5%	5%	5%	16%	0%	6%	15%	45%	11%	21%	50%	56%

Shaded cells indicate value above standard

[a] Stream flow zero; no data collected

Conclusions

The following conclusions were reached from analysis of the data from 1999-2000 and from observations recorded while in the field.

Raft River

Total suspended solid concentrations are high on the Raft River from November to June.

- Major source of sediment appears to be streambank erosion and sloughing of cut banks.
- Lack of riparian vegetation provides little root structure to stream banks during high flows.
- Incised stream channel reduces storage of high flows in stream banks and flood plains that would reduce peak flows and increase base flows during summer.

Total suspended solid concentrations are of concern on the Raft River. The major non-point source of sediment through the Upper Raft River Valley appears to be stream bank erosion. Total suspended sediment loads in the Raft River appear to be related to the condition of the river channel. The river has incised anywhere from 4-12 feet between sites RR1 and RR3 during the past decades. Vertical and unvegetated cut banks resulting from this down cutting are common and are a large source of sediment input to the Raft River. The riverbed does not currently appear to be degrading but the channel is eroding laterally into cut banks to establish channel morphology appropriate for its lower base level.

Low stream flows over much of the Raft River appear to be an important factor in the distribution and amounts of streamside vegetation and the river's ability to reduce flood flows and trap sediment. Actions to increase stream flow directly are beyond the scope of agricultural best management practices. However, efforts to increase riparian vegetation through agricultural BMPs should increase low summer flows over time and provide more root structure in stream banks to reduce bank erosion. Grazing on some reaches of the river appears to be limiting the ability of vegetation to reestablish. This is the major agricultural impact on water quality on the Raft River and efforts to improve water quality through agricultural best management practices should focus on improved grazing management directly along the river corridors. The development of an active floodplain with riparian vegetation to provide root structure to stream banks will be important in meeting TMDL sediment levels and maintaining higher summer flow levels in the future.

Edwards and Almo Creeks

- Bacteria levels are of concern on Edwards and Almo Creeks. Almo Creek showed particularly high counts.
- Sediment transport, head cutting and erosion from unregulated flood irrigation is apparent on lower portions of Edwards Creek.

Water quality data indicates that suspended solid loads on Edwards and Almo Creek were relatively low. Although suspended solid concentrations were low, erosion and transport of sediment is significant in certain sections of the streams. Alteration of stream channels and diversion of water has caused headcutting and downcutting on both creeks. Uncontrolled diversions and flood irrigation of pastures have created erosion problems where flows return to the stream channels.

Recommendations

Raft River

Agricultural best management practices along the Raft River should emphasize the following:

- Grazing management along the river that improves riparian vegetation.
- Establishment or maintenance of buffer strips along streams that will allow riparian vegetation to establish and provide root structure to stream banks.

Although much of the healing to take place on the Raft River will be by natural processes, grazing management will affect how the natural processes take place. Grazing along the river should not be continuous for any specific pasture. The reduction or elimination of grazing directly along the river will greatly enhance the recovery of vegetation and bank stabilization.

Edwards and Almo Creeks

Agricultural best management practices along Almo and Edwards Creeks should:

- Reduce bacterial contamination from livestock sources along streams, particularly on Almo Creek.
- Improve irrigation diversions and flood irrigation over steep pastureland.
- Improve grazing management along streams to increase riparian vegetation.

Bacteria concentrations were high and often above state standards. The source appears to be from livestock grazing along the creeks, residential septic systems or a combination of the two. Agricultural best management practices should concentrate on reducing direct access to the creek by livestock. Although not an agricultural issue, potential impacts from residential septic systems should be evaluated as well.

Unregulated diversions of water during spring runoff appear to be the main cause of headcutting and gully formation near the confluence of Edwards and Almo Creeks. Agricultural best management practices on these two creeks should focus on improving water diversions to reduce unregulated surface flow over pasture and rangeland. Livestock management should aim to improve riparian vegetation along the streams to provide root structure and bank protection from high stream flows.

References

1. Mark Dallon, 1999. Raft River and Almo Subwatershed Water Quality Monitoring Project. Idaho Association of Soil Conservation Districts.

2. Brennan, T.S., A.M. Campbell, A.K. Lehmann, and I. O'Dell, 2001. Water Resources Data – Idaho, Water Year 2000, Volume 1. Great Basin and Snake River Basin above King Hill. United States Geological Survey, Department of the Interior.

3. East Cassia Soil Conservation District, Raft River Flood Control District, Cassia County Commissioners, 1998. Raft River Riparian and Watershed Restoration Demonstration Project, Implementation for the Almo Sub-basin.

4. Division of Environmental Quality, 1998. 1998 303(d) List. State of Idaho, Division of Environmental Quality.

5. United State Geological Survey: http://water.usgs.gov/nwis/dvstat/?site_no=13078000 December 27, 2001.

6. United State Geological Survey: http://water.usgs.gov/nwis/dvstat/?site_no=13079901 December 27, 2001

7. Idaho State Climate Services: http://snow.ag.uidaho.edu:8888/month_index.htm December 27, 2001.

8. Western Regional Climate Center: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?idmalt, December 27, 2001.

Appendix A
Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC)

Procedures for quality assurance and quality control for this project were outlined prior to monitoring in the "Water Quality Monitoring Plan for Raft River, Almo Subwatershed", developed in May of 1999 (Dallon, 1999).

Samples were analyzed by Magic Valley Labs, in Twin Falls, Idaho. Magic Valley Labs uses EPA approved and validated methods.

Duplicate samples and blank samples were collected as part of the field QA/QC procedures. Duplicates and blanks were collected at 10% of the total sample load. Blank samples consisted of deionized water handled as if it were a normal sample. For samples requiring filtering, deionized water was put through the filtration unit and transferred to a sample container. There were no constituents detected above the detection limit for any of the blank samples analyzed during this project.

The duplicate samples were collected at various sites over the first two months of the project. Two duplicate samples were taken at the Almo Creek site and one duplicate was taken at site EC1. All of the duplicates after August of 1999 were collected at site RR1. Duplicate samples were not identified as such for analysis by the laboratory to determine laboratory precision. Blank and duplicate samples were stored, handled and transported with the other samples to the laboratory. No blank samples recorded values over the minimum detection limits for any parameter. A comparison of mean values for parameters and the mean value of duplicate samples for those parameters at the various sites is presented in Table 10.

Table 10. Duplicate Mean Values and Comparison

Parameters	RR1 Mean	Duplicate Mean	Percent
TSS	28.7	29.6	97.0
TVSS	6.6	6.3	104.8
Fecal Coliform	247.1	200.0	123.6
E. Coli	76.5	101.4	75.4

The relative percent difference (RPD) between each parameter and its corresponding duplicate sample are presented in Table 5. The RPD is a measure of precision for duplicate samples and is calculated with the following equation:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2) / 2}$$

RPD = relative percent difference
C_1 = Larger of two samples
C_2 = Smaller of two samples

Table 11. Relative Percent Difference (duplicates)

Collection Date	TSS	Dup-licate TSS	RPD	E.Coli	Dup-licate E.Coli	RPD	Fecal Coli-form	Dup-licate Fecal	RPD
6/28/99	8	8	0.0	20	60	100.0	130	180	32.3
7/13/99	8	8	0.0	10	70	150.0	600	800	28.6
7/29/99	12	6	66.7	40000	400	196.0	160000	1800	195.6
8/24/99	<1	5	133.3	200	200	0.0	1200	300	120.0
9/7/99	8	11	31.6	100	200	66.7	300	400	28.6
10/11/99	3	6	66.7	180	160	11.8	220	190	14.6
10/28/99	8	8	0.0	70	60	15.4	70	90	25.0
11/22/99	4	4	0.0	40	60	40.0	50	90	57.1
12/20/00	29	32	9.8	40	30	28.6	70	50	33.3
1/26/00	69	69	0.0	<2	<2	0.0	80	90	11.8
2/23/00	74	75	1.3	20	10	66.7	90	50	57.1
4/11/00	128	134	4.6	100	100	0.0	300	100	100.0
4/24/00	39	39	0.0	100	70	35.3	100	210	71.0
5/31/00	32	31	3.2	90	50	57.1	120	200	50.0
6/14/00	8	8	0.0	100	50	66.7	130	50	88.9

Precision was very good for TSS and TVSS and fair for fecal coliform and E. Coli bacteria. Since bacteria samples are taken as grab samples and not composited, more variation would not be surprising. Only one duplicate sample (7/29/99) was of particular concern.

Appendix B
Water Quality Data
Sheets

Data Sheets
Raft River, Almo Creek, Edwards Creek

Raft River 1	RR1											
Date	Q ft^3/s	DO mg/L	Temp Cel	Cond µS	Salinity ppt	TDS mg/L	pH	TSS mg/L	TVSS mg/L	Fecal Coliform CFU/100mL	E. Coli CFU/100mL	Time
14-Jun-99	71.2	7.12	18.5	746	0.4	359	8.32	137	-	300	200	15:00
28-Jun-99	22.9	9.58	14.1	972	0.5	470	8.04	8	7	130	20	10:15
13-Jul-99	15.0	8.46	15.7	944	0.5	455	8.20	12	3	300	100	9:30
29-Jul-99	5.1	7.60	19.8	1235	0.6	601	8.08	7	6	1700	800	15:15
12-Aug-99	6.7	8.60	15.1	1312	0.6	640	7.98	5	3	310	70	9:30
24-Aug-99	4.7	8.17	17.4	1277	0.6	623	7.80	7	5	400	100	9:00
7-Sep-99	4.3	8.49	15.2	1276	0.6	619	8.09	8	3	300	100	10:45
27-Sep-99	4.7	9.50	9.9	1342	0.7	644	8.14	8	3	200	70	10:45
11-Oct-99	5.2	9.15	11.7	1295	0.6	629	8.22	3	2	220	180	11:30
28-Oct-99	6.1	9.35	10.6	1317	0.6	632	8.10	8	4	70	70	11:00
22-Nov-99	9.9	10.71	4.7	1164	0.5	542	8.29	4	4	50	40	11:00
20-Dec-99	16.6	11.19	3.1	984	0.5	452	8.48	29	8	70	40	11:00
26-Jan-00	22.9	10.56	5.2	892	0.4	414	n/a	69	6	80	<2	11:45
23-Feb-00	25.3	10.28	6.3	871	0.4	407	n/a	74	10	90	20	11:30
14-Mar-00	24.8	9.76	8.6	855	0.4	407	8.17	31	7	200	100	11:30
11-Apr-00	30.4	9.77	8.4	741	0.4	350	8.02	128	18	300	100	9:45
24-Apr-00	25.8	9.26	10.8	753	0.4	362	7.96	39	7	100	100	11:30
16-May-00	16.1	8.82	13.1	939	0.5	451	8.09	32	7	30	10	11:30
31-May-00	8.1	8.48	14.8	1187	0.6	573	8.04	32	8	120	90	10:00
14-Jun-00	4.4	7.72	19.4	1285	0.6	628	7.96	8	4	130	100	11:00

Raft River 2	RR2											
Date	Q	DO	Temp	Cond	Salinity	TDS	pH	TSS	TVSS	Fecal Coliform	E. Coli	Time
	ft^3/s	mg/L	Cel	µS	ppt	mg/L		mg/L	mg/L	CFU/100mL	CFU/100mL	
14-Jun-99	47.9	7.48	18.7	532	0.3	253	8.50	111	-	1000	100	13:50
28-Jun-99	14.7	8.91	15.8	584	0.3	280	8.34	5	3	160	50	11:30
13-Jul-99	7.0	7.54	18.3	638	0.3	306	8.28	16	5	400	150	10:30
29-Jul-99	0.1	7.22	21.6	1042	0.5	504	8.06	7	5	180	10	14:30
12-Aug-99	0.7	8.46	14.9	966	0.5	464	8.02	12	5	1300	150	10:45
24-Aug-99	0.1	8.05	17.3	834	0.4	403	7.86	10	6	200	90	10:00
7-Sep-99	0.4	8.69	13.7	831	0.4	400	8.09	10	3	700	50	12:00
27-Sep-99	0.5	10.35	7.4	931	0.4	441	8.14	9	3	500	200	12:00
11-Oct-99	0.0	-	-	-	-	-	-	-	-	-	-	-
28-Oct-99	0.7	9.97	7.7	1058	0.5	504	8.21	10	6	3100	3000	12:00
22-Nov-99	3.3	12.01	0.8	772	0.4	344	8.76	53	10	400	300	11:45
20-Dec-99	8.5	12.12	0.1	707	0.3	324	8.39	48	12	70	<10	12:00
26-Jan-00	14.2	11.12	2.9	645	0.3	296	n/a	131	18	280	240	13:00
23-Feb-00	15.7	10.73	4.6	644	0.3	297	n/a	49	9	20	<10	12:30
14-Mar-00	14.8	10.31	6.3	623	0.3	293	8.14	54	10	20	20	12:30
11-Apr-00	22.6	9.96	7.5	520	0.2	247	8.13	130	22	200	10	10:45
24-Apr-00	16.1	9.11	11.2	553	0.3	263	8.25	54	10	40	20	12:30
16-May-00	10.9	8.77	13.2	646	0.3	309	8.35	59	42	150	20	12:15
31-May-00	1.1	8.35	15.2	832	0.4	403	8.21	<1	<1	100	70	11:30
14-Jun-00	1.6	9.84	19.6	838	0.4	403	8.01	5	3	100	100	12:00

Raft River 3	RR3											
Date	Q ft^3/s	DO mg/L	Temp Cel	Cond µS	Salinity ppt	TDS mg/L	pH	TSS mg/L	TVSS mg/L	Fecal Coliform CFU/100mL	E. Coli CFU/100mL	Time
14-Jun-99	44.9	7.77	17.1	509	0.2	244	8.45	97	-	300	100	12:30
28-Jun-99	10.6	9.18	18.0	514	0.2	246	8.63	6	6	140	60	12:30
13-Jul-99	7.5	8.11	19.4	550	0.3	263	8.35	4	<1	400	300	12:00
29-Jul-99	0.3	7.22	21.6	587	0.3	281	8.41	7	4	700	300	13:00
12-Aug-99	0.8	8.39	15.1	674	0.3	323	8.23	2	<1	1600	210	11:30
24-Aug-99	0.1	7.99	17.5	644	0.3	309	8.18	6	4	500	400	11:00
7-Sep-99	0.4	8.31	15.9	640	0.3	307	8.34	4	3	110	40	13:00
27-Sep-99	0.5	9.40	9.8	640	0.3	304	8.33	8	3	200	100	12:50
11-Oct-99	0.5	8.78	12.7	646	0.3	310	8.44	3	2	200	100	12:45
28-Oct-99	1.5	9.26	10.3	696	0.3	332	8.23	5	2	230	200	13:00
22-Nov-99	6.7	11.24	2.7	629	0.3	284	8.54	12	5	60	20	12:30
20-Dec-99	9.8	11.61	1.5	568	0.3	261	n/a	20	6	<10	<10	13:15
26-Jan-00	12.5	10.82	3.5	581	0.3	267	n/a	61	9	40	10	14:30
23-Feb-00	14.0	10.45	5.2	536	0.2	248	n/a	18	6	10	<10	13:15
14-Mar-00	14.1	9.78	8.0	526	0.2	249	8.09	33	10	110	90	13:30
11-Apr-00	19.4	9.49	9.3	451	0.2	215	8.25	86	14	170	30	12:00
24-Apr-00	16.2	9.21	10.5	487	0.2	232	8.22	31	7	20	<10	13:30
16-May-00	7.2	8.64	13.5	545	0.3	261	8.39	18	7	40	10.0	13:00
31-May-00	0.0	-	-	-	-	-	-	-	-	-	-	-
14-Jun-00	0.0	-	-	-	-	-	-	-	-	-	-	-

Edwards Creek 1	**EC1**											
Date	**Q**	**DO**	**Temp**	**Cond**	**Salinity**	**TDS**	**pH**	**TSS**	**TVSS**	**Fecal Coliform**	**E. Coli**	**Time**
	ft^3/s	mg/L	Cel	µS	ppt	mg/L		mg/L	mg/L	CFU/100mL	CFU/100mL	
14-Jun-99	45.5	8.10	16.0	689	0.3	326	8.18	31	-	800	450	11:30
28-Jun-99	2.8	7.09	20.6	832	0.4	401	8.35	5	3	80	100	14:00
13-Jul-99	0.5	7.28	21.2	1053	0.5	508	8.06	7	6	1100	300	13:30
29-Jul-99	0.3	8.21	16.4	1036	0.5	503	7.91	12	9	1200	300	9:30
12-Aug-99	0.2	7.79	18.7	1173	0.6	569	8.04	7	7	60	30	12:30
24-Aug-99	0.2	8.13	16.9	1114	0.5	541	7.80	<1	<1	1200	200	12:00
7-Sep-99	0.1	7.73	18.6	1171	0.6	569	8.00	16	6	1200	400	15:00
27-Sep-99	0.3	8.88	12.6	1216	0.6	588	8.04	23	6	47000	21000	14:30
11-Oct-99	0.3	8.64	13.8	1292	0.6	629	8.13	6	4	3000	2300	13:45
28-Oct-99	0.3	9.21	11.0	1289	0.6	623	8.13	10	7	1400	1000	14:00
22-Nov-99	0.4	10.86	4.3	1296	0.6	602	8.05	3	3	10	10	14:00
20-Dec-99	0.6	11.08	3.2	1044	0.5	479	n/a	6	3	70	<10	14:00
26-Jan-00	1.2	10.44	5.2	720	0.3	331	n/a	6	3	40	<2	15:00
23-Feb-00	1.8	10.28	6.2	597	0.3	277	n/a	8	4	100	100	14:15
14-Mar-00	1.8	9.36	10.1	581	0.3	275	7.93	25	9	180	<10	15:15
11-Apr-00	0.8	8.24	15.9	946	0.5	456	7.94	6	6	120	<10	14:00
24-Apr-00	0.7	8.07	16.7	817	0.4	395	7.78	8	6	170	130	14:30
16-May-00	0.2	8.10	16.6	976	0.5	472	7.94	5	4	100	20	14:00
31-May-00	0.2	7.57	20.0	912	0.4	440	8.20	6	4	200	180	15:30
14-Jun-00	0.2	11.79	22.6	1072	0.5	519	7.77	6	4	1100	560	13:15

Edwards Creek 2	**EC2**											
Date	**Q**	**DO**	**Temp**	**Cond**	**Salinity**	**TDS**	**pH**	**TSS**	**TVSS**	**Fecal Coliform**	**E. Coli**	**Time**
	ft^3/s	mg/L	Cel	µS	ppt	mg/L		mg/L	mg/L	CFU/100mL	CFU/100mL	
14-Jun-99	25.2	9.13	14.8	606	0.3	293	8.06	8	-	700	500	10:00
28-Jun-99	3.1	6.79	20.4	664	0.3	319	8.14	5	5	1400	300	15:00
13-Jul-99	0.1	7.50	21.4	649	0.3	348	8.17	4	3	900	100	14:00

Edwards Creek 3	**EC3**											
Date	**Q** ft^3/s	**DO** mg/L	**Temp** Cel	**Cond** µS	**Salinity** ppt	**TDS** mg/L	**pH**	**TSS** mg/L	**TVSS** mg/L	**Fecal Coliform** CFU/100mL	**E. Coli** CFU/100mL	**Time**
14-Jun-99	5.1	8.16	15.5	265	0.1	127	8.18	20	-	600	400	11:30
28-Jun-99	2.2	7.98	16.7	165	0.1	78	8.16	27	12	90	20	15:45
13-Jul-99	0.1	7.69	16.6	146	0.1	69	8.06	5	6	280	100	14:30
29-Jul-99	0.1	8.12	16.2	270	0.1	128	8.17	11	6	600	200	10:30
12-Aug-99	0.1	7.84	17.9	298	0.1	142	8.33	9	7	900	40	13:45
24-Aug-99	0.1	7.94	17.7	301	0.1	143	8.29	<1	<1	1400	300	13:00
7-Sep-99	0.1	8.29	15.8	252	0.1	120	8.52	1	<1	500	150	14:00
27-Sep-99	0.1	9.14	11.2	370	0.2	175	8.35	2	1	300	100	15:40
11-Oct-99	0.6	8.79	12.6	89	0.0	42	8.05	8	5	2700	2000	15:00
28-Oct-99	0.9	9.52	9.3	111	0.1	51	7.68	28	13	1400	1200	14:45
22-Nov-99	0.8	12.03	0.1	115	0.1	50	8.22	11	6	600	300	15:00
20-Dec-99	0.5	11.65	1.0	91	0.0	40	n/a	3	1	130	20	15:15
26-Jan-00	0.5	11.32	1.7	102	0.0	45	n/a	<1	<1	50	30	15:45
23-Feb-00	0.6	11.08	2.9	100	0.0	45	n/a	12	8	20	<10	15:00
14-Mar-00	0.6	9.87	7.4	89	0.0	41	8.09	29	15	200	20	16:00
11-Apr-00	1.3	9.02	11.0	93	0.0	44	7.56	44	14	150	<10	13:30
24-Apr-00	1.3	8.83	12.0	116	0.1	54	7.59	22	9	210	70.0	15:15
16-May-00	0.2	8.74	12.4	173	0.1	82	7.70	9	6	90	40.0	15:00
31-May-00	0.1	7.80	17.6	290	0.1	138	8.06	6	4	150	40.0	14:30
14-Jun-00	0.0	-	-	-	-	-	-	-	-	-	-	-

Almo Creek	ALMO											
Date	Q ft^3/s	DO mg/L	Temp Cel	Cond µS	Salinity ppt	TDS mg/L	pH	TSS mg/L	TVSS mg/L	Fecal Coliform CFU/100mL	E. Coli CFU/100mL	Time
14-Jun-99	7.4	8.38	15.8	194	0.1	93	8.14	25	-	2000	1000	13:00
28-Jun-99	5.8	7.95	18.6	154	0.1	73	8.28	34	13	1120	900	16:15
13-Jul-99	0.2	7.26	22.6	328	0.2	154	8.50	8	4	600	10	15:00
29-Jul-99	0.1	6.98	22.1	441	0.2	209	8.58	12	7	160000	40000	11:30
12-Aug-99	0.1	7.52	19.8	284	0.1	135	8.77	5	4	510	150	14:15
24-Aug-99	0.0	-	-	-	-	-	-	-	-	-	-	13:45
7-Sep-99	0.0	-	-	-	-	-	-	-	-	-	-	-
27-Sep-99	0.0	-	-	-	-	-	-	-	-	-	-	-
11-Oct-99	0.0	-	-	-	-	-	-	-	-	-	-	-
28-Oct-99	0.7	9.60	9.1	304	0.1	142	8.09	5	1	1200	900	15:30
22-Nov-99	0.8	11.54	1.8	278	0.1	124	8.70	4	4	110	90	15:30
20-Dec-99	0.5	11.49	1.7	336	0.2	149	n/a	<1	<1	260	30	16:00
26-Jan-00	1.6	11.21	2.3	340	0.2	151	n/a	2	2	100	80	16:20
23-Feb-00	1.3	10.76	4.3	301	0.1	137	n/a	4	5	900	800	15:30
14-Mar-00	1.5	9.72	8.3	270	0.1	126	8.53	5	3	200	<10	14:30
11-Apr-00	1.5	9.07	10.7	405	0.2	192	8.43	5	5	800	500	12:45
24-Apr-00	7.7	9.01	11.5	127	0.1	60	7.96	54	11	1700	1100	16:00
16-May-00	1.4	8.36	14.6	302	0.1	144	7.90	11	9	150000	100000	16:00
31-May-00	1.2	8.21	15.9	275	0.1	130	8.06	8	4	3300	3300	13:30
14-Jun-00	5.8	8.57	17.4	103	0.0	48	7.85	16	5	100	100	14:15